4.4 Case IV: High Winds in Smith Sound, 7 April 1989

4.4.1 Introduction

High winds in the Arctic are certainly not uncommon but they may originate from a large variety of synoptic and local conditions. Among these cases are cold outbreaks *being enhanced by downslope flow over the glaciers.*

The present case is an example of pre-cold frontal winds being strengthened by a channeling effect as southwesterly flow, ahead of a cold front, funnels into Smith Sound between Ellesmere Island and northern Greenland. Winds in excess of 66 mph and perhaps up to 100 mph were observed at Ice Camp APLIS 89 most of the day on 7 April 1989. The synoptic situation will be described with surface and upper air charts, visible and IR satellite imagery, and time series of the observed weather parameters.

4.4.2 0000 GMT 7 April 1989

Figure 4-46 is a locator map for the area involved in this case study. Ice Camp APLIS 89 at the time of the highest winds was located in Smith Sound approximately 13 miles from the Greenland coast.

Figure 4-47 is the 500-mb chart for 0000 GMT 7 April 1989. The pertinent feature on this chart is the relatively short-wave trough oriented northeast-southwest and extending from northwestern Ellesmere Island to southwestern Victoria Island. At this time, therefore, an upper trough is approaching Smith Sound and the winds in that region are westerly.

At the surface (Fig. 4-48), for the corresponding time, the trough is in a position east of the 500-mb trough that would be expected, considering the slope of cold troughs. More precisely, the surface trough lies between Victoria and Baffin Islands.

The thermal pattern on the surface chart shows the $-16\,°C$ isotherm outlining a relatively *warm pocket* of air (normally, cold air would be expected) moving eastward toward Ellesmere Island. Consequently, at this time increasing cloudiness and increasing southwest winds could be expected as the trough approaches Smith Sound; significant warming must also be anticipated.

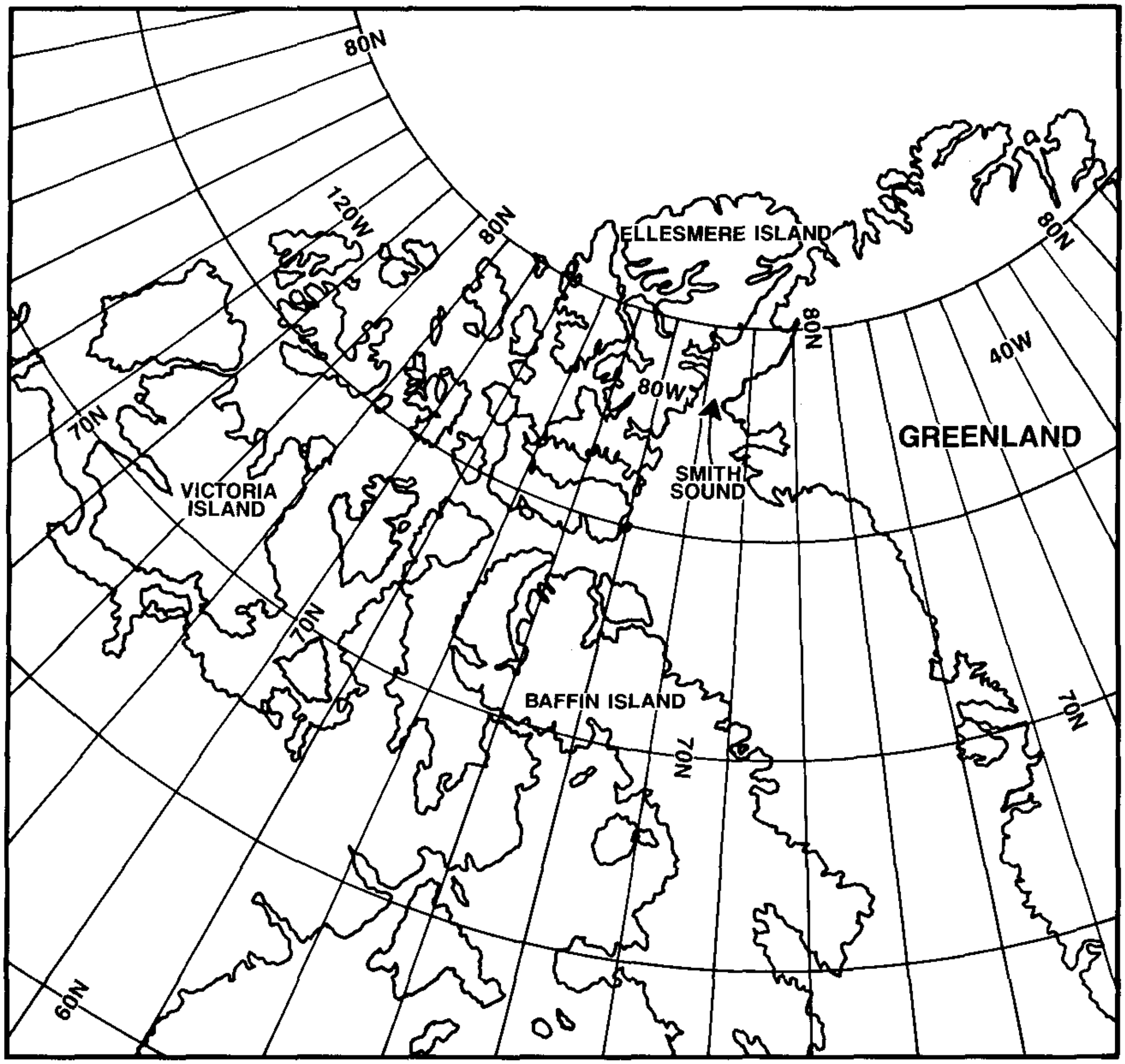

Figure 4-46. Locator Map for the Smith Sound Region.

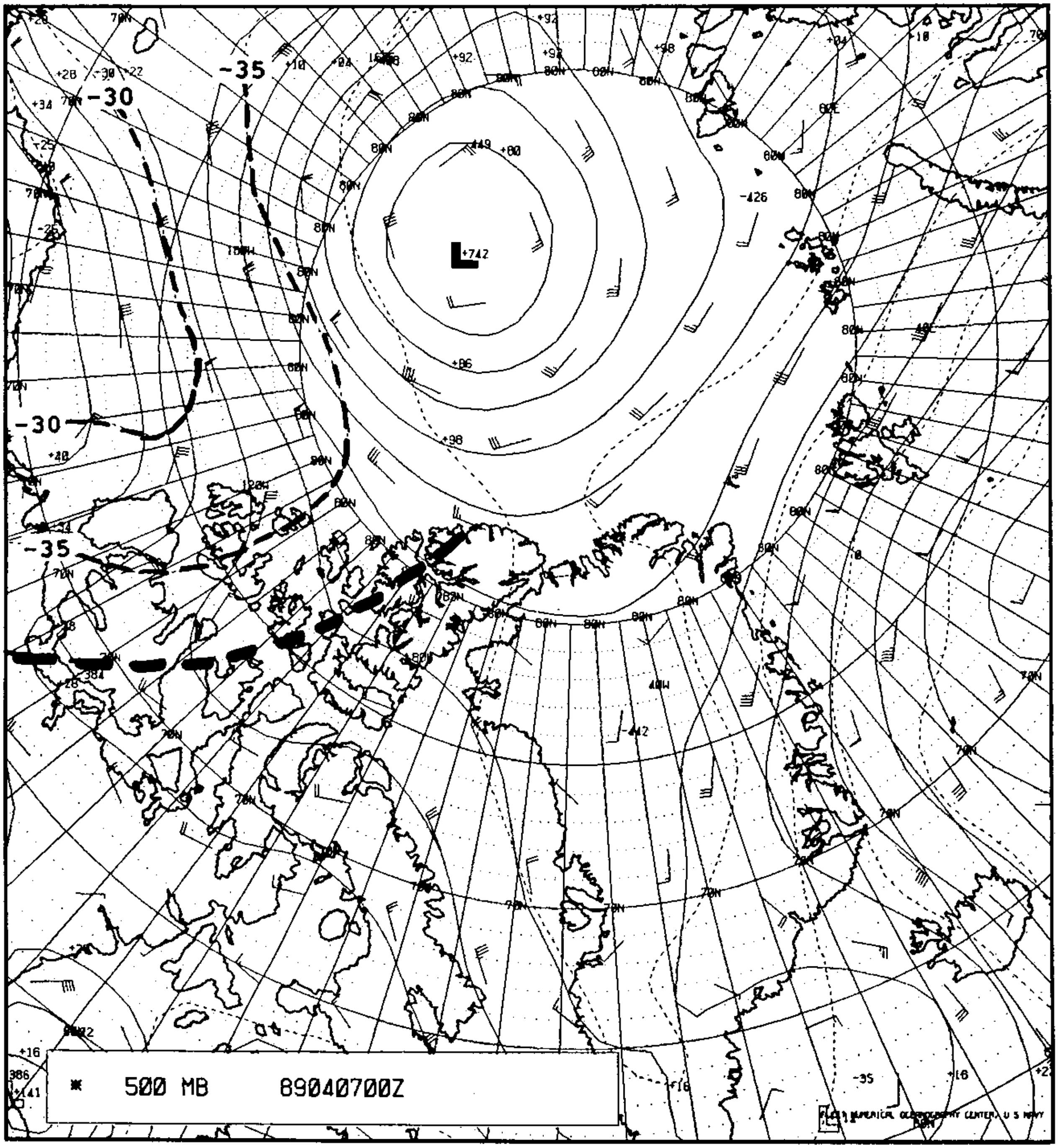

Figure 4-47. FNOC 500-mb Chart, 0000 GMT 7 April 1989.

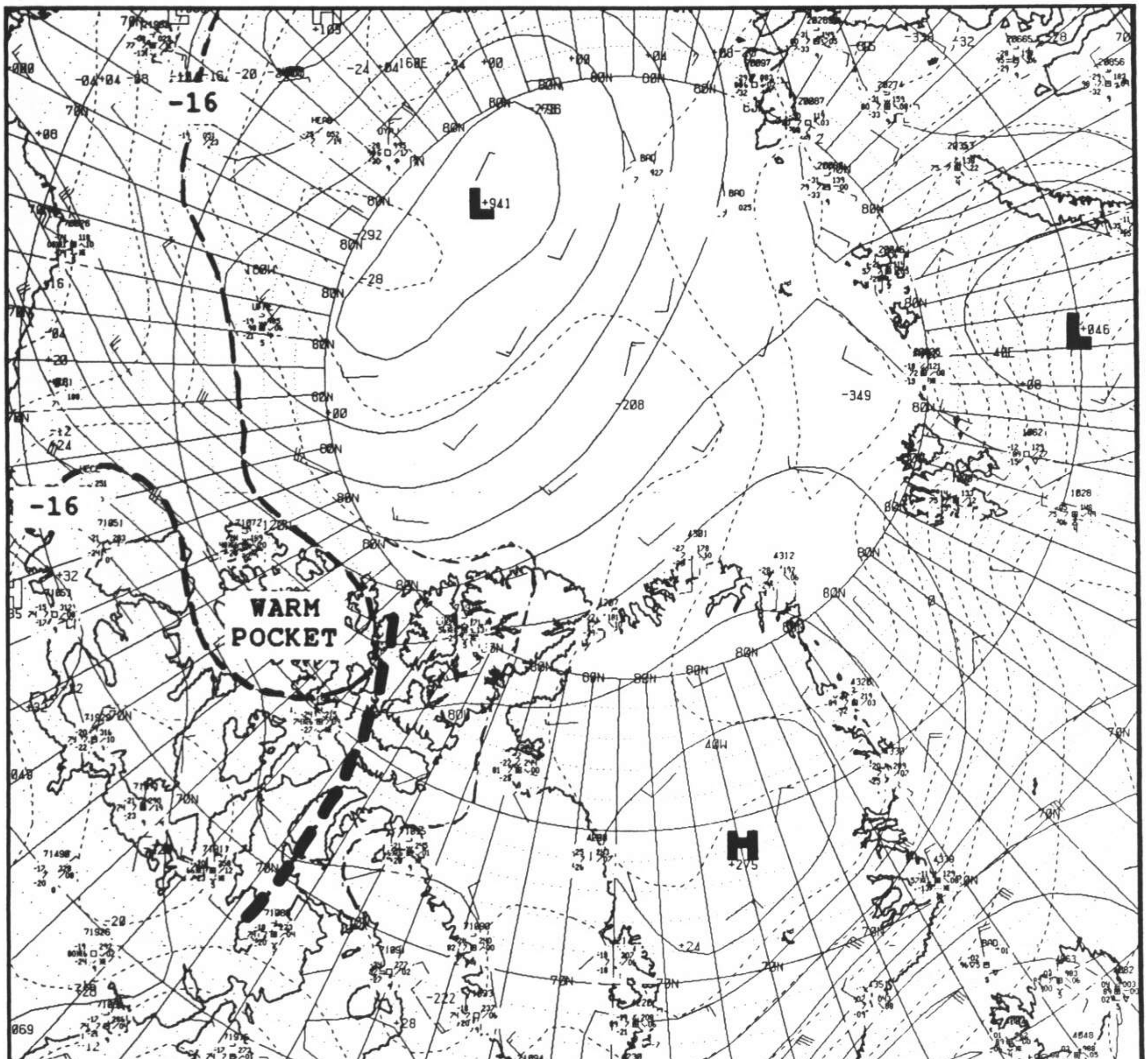

Figure 4-48. FNOC Surface Chart, 0000 GMT 7 April 1989.

4.4.3 1200 GMT 7 April 1989

The well defined surface trough in the vicinity of Ellesmere Island, which appeared on the 0000 GMT chart, weakened somewhat during the subsequent 12 hours, as can be noted on the 1200 GMT surface chart for 7 April 1989 (Fig. 4-49). The flow in the area of interest has become slightly more westerly, and the pressure gradient to the southwest of Ellesmere has intensified. Interestingly, the trough appears to have separated, with the northern portion of the trough moving more rapidly eastward than did the southern portion. The northern portion of the trough is over the west coast of Greenland at this time while the southern portion loses its identity. In the meantime, the warm tongue, outlined by the −16 °C isotherm, has advanced eastward also, bringing warmer air closer to Smith Sound.

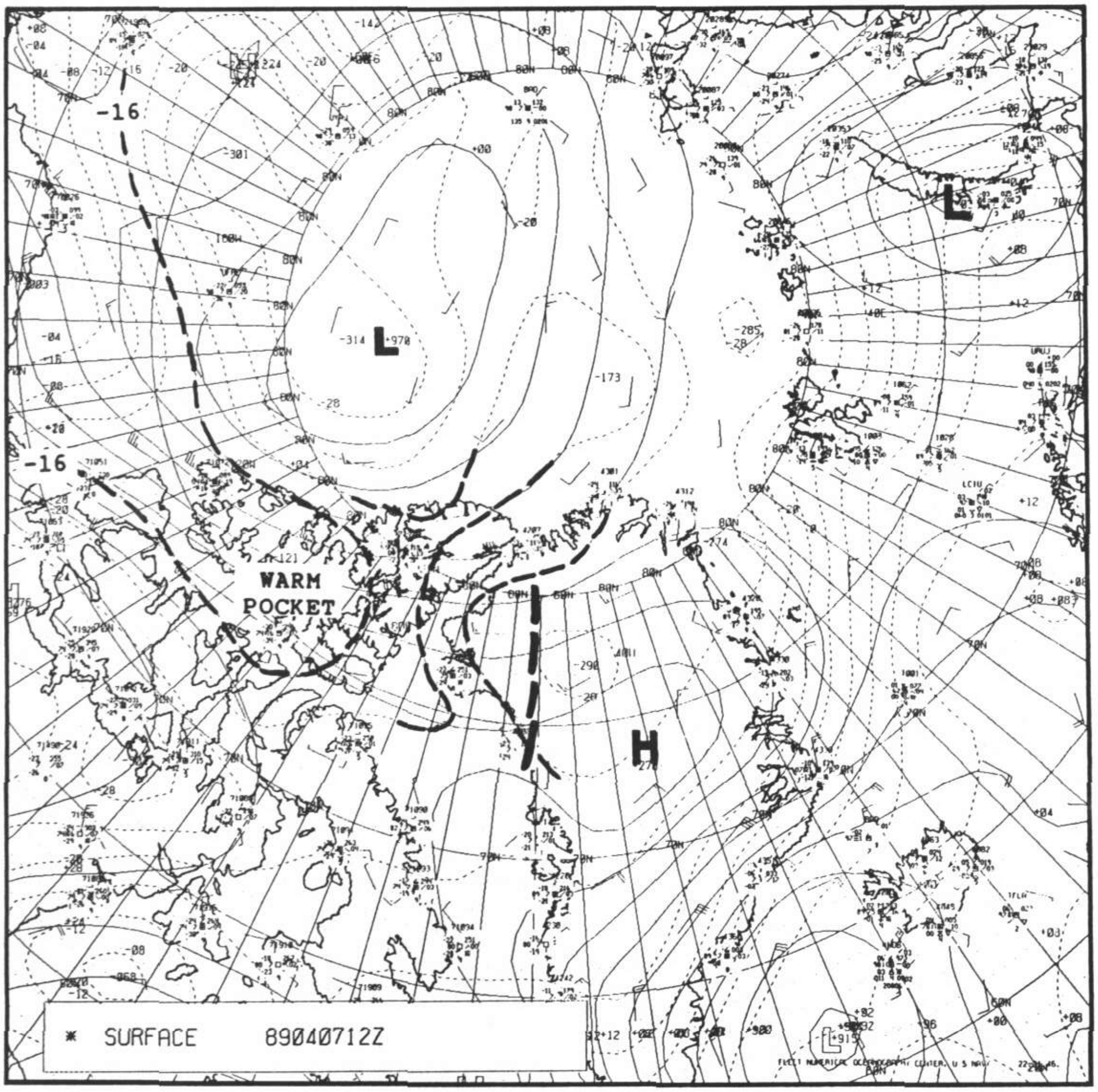

Figure 4-49. FNOC Surface Chart, 1200 GMT 7 April 1989.

At 500 mb (Fig. 4-50), the separation of the northern and southern portions of the trough is even more obvious. The northern portion of the trough at 1200 GMT approached central Greenland while the southern portion lingered over northern Baffin Island. This separation of the trough may have implications that are not obvious at this time.

Note that a comparison of the surface and 500-mb charts shows warm advection common to both in the area of interest around Ellesmere Island. The surface warm advection appears, however, to be much stronger near the surface than at 500 mb, which implies that some destabilization of the air is occurring. Also note that warm advection decreasing with height can be just as effective in the destabilization process as low level warm advection topped by upper level cold advection.

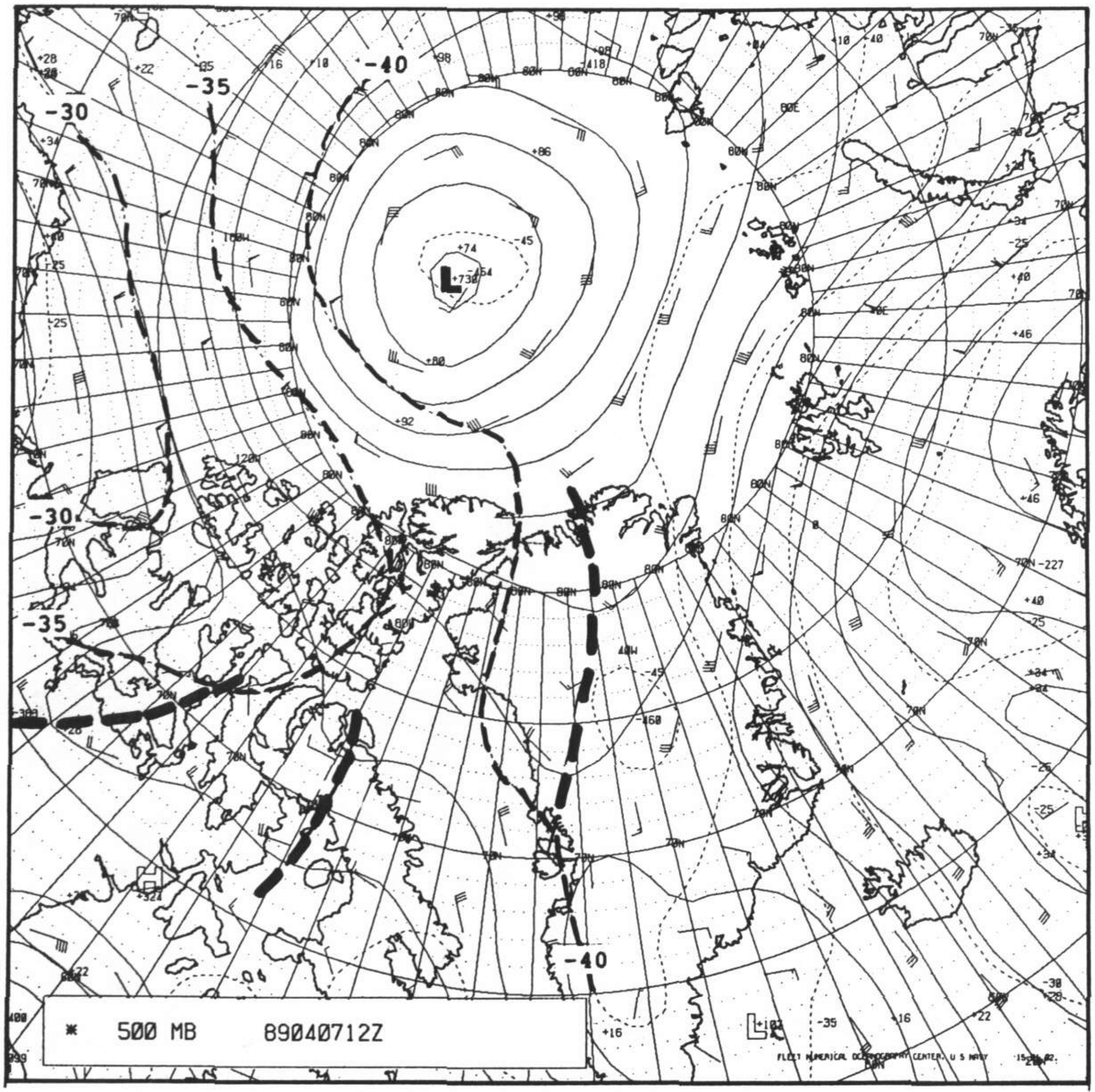

Figure 4-50. FNOC 500-mb Chart, 1200 GMT 7 April 1989.

Satellite imagery for this time is presented in Figs. 4-51 and 4-52. Figure 4-51, the visible DMSP imagery, shows a wide frontal band stretching northeast-southwest just north of Ellesmere Island and Greenland. Significantly, a developing wave appears on the frontal band and indicates cyclogenesis just north of the area in which strong winds developed on 7 April. The structure and intensity of the wave is better defined in the IR DMSP satellite imagery (Fig. 4-52). Clearly, Smith Sound is southeast of this deepening wave and would lie in the developing warm sector of the system.

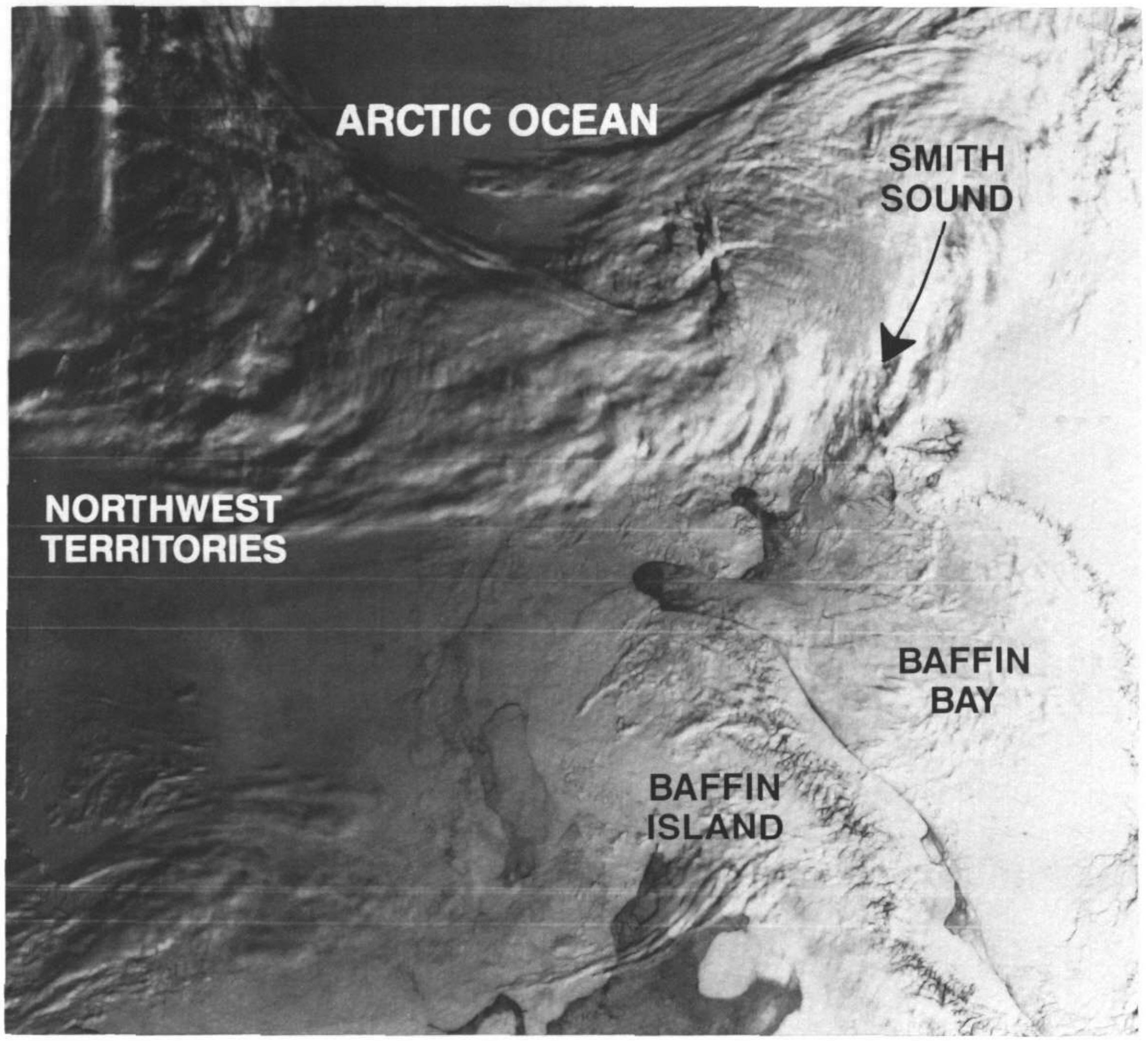

Figure 4-51. Visible DMSP Satellite Imagery, 1400 GMT 7 April 1989.

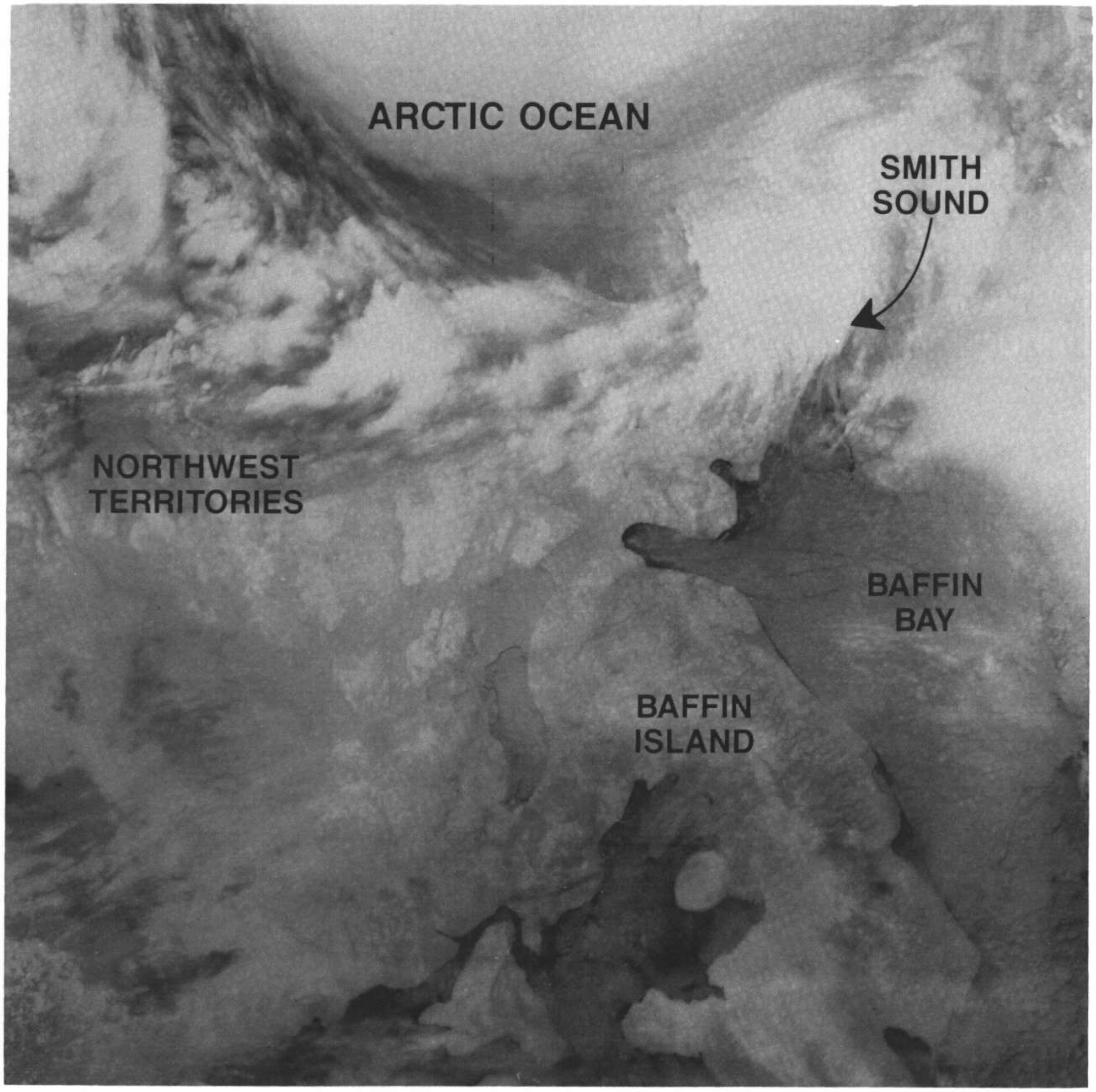

Figure 4-52. IR DMSP Satellite Imagery, 1400 GMT 7 April 1989.

Figure 4-53 is a time series of various weather parameters as observed at Ice Camp APLIS 89. Clearly, as shown in this figure, considerable warming occurred at the surface during the morning hours of 7 April. This trend is consistent with the earlier observation of warm advection on the surface chart (Fig. 4-49).

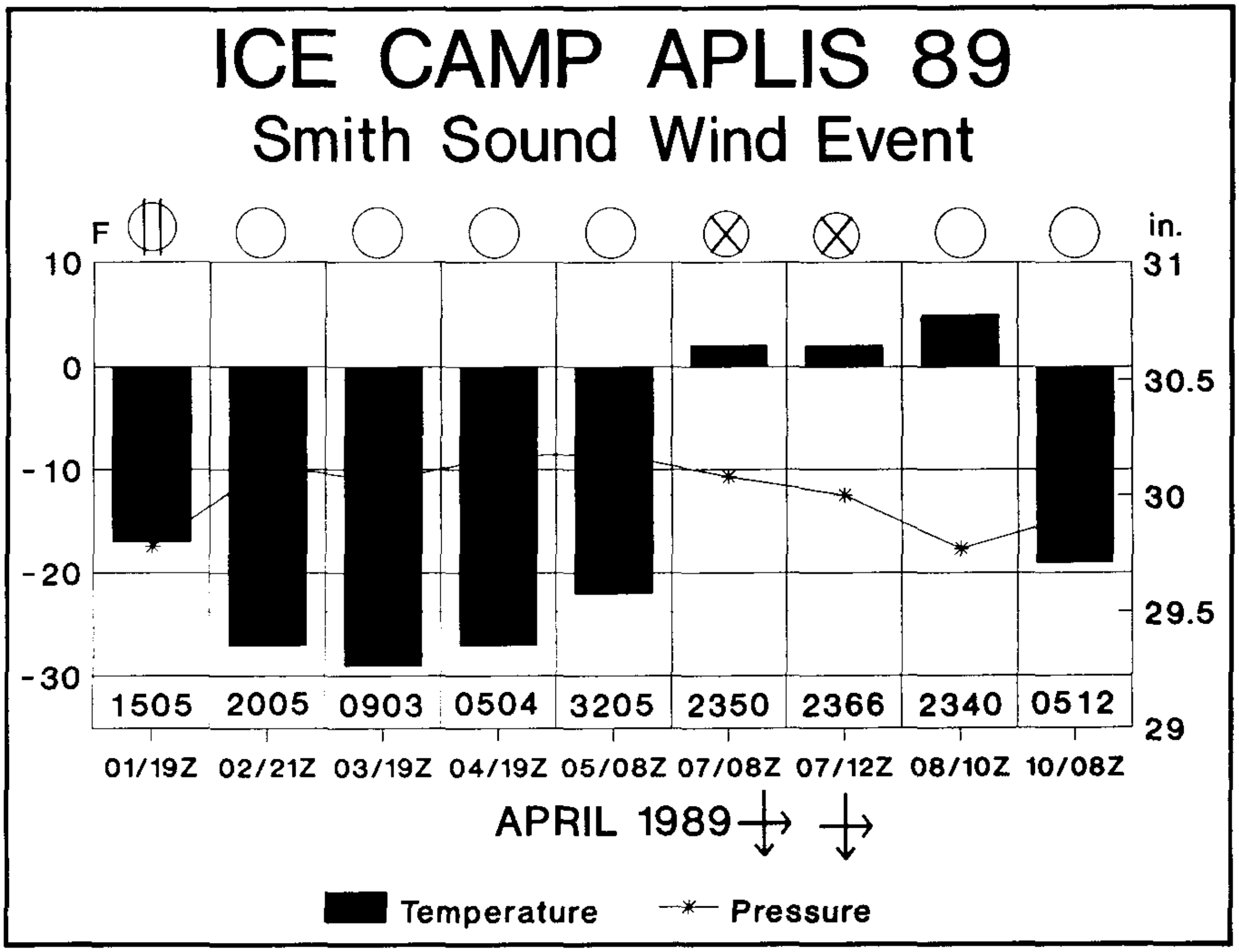

Figure 4-53. *Time Series of Surface Weather for Ice Camp APLIS 89. NOTE: Observation times are irregular. (Left ordinate is temperature [°F] and right ordinate is pressure [mb]. Wind direction and speed [DDFF in tens of degrees and miles per hour] are shown in the block below the temperature/dew-point data. Present weather symbols are shown below the date/time group information.)*

Accompanying the warming was the onset of overcast skies and a considerable increase in wind speed and the onset of blowing snow. The fact that winds increased from very light winds on 5 April (5 mph) and 6 April (15 mph—not shown) to 50 and then 66 plus mph by 1200 GMT indicates that dangerous wind conditions approaching hurricane force reached Smith Sound during this period and persisted throughout most of the day at the ice camp. Records from the ice camp show that the winds did not abate until the next day (8 April) when skies cleared and the surface pressure reached its minimum value of 29.67 in of mercury.

Navy Captain Dorman of the Arctic Submarine Laboratory at San Diego was at the ice camp during this high wind event and attests to the fact that the situation was life-threatening, the camp being only 2 mi ($\approx$ 3 km) from open water. Captain Dorman maintains that the wind speed may have reached as high as 100 mph; however, since the anemometer blew away, this estimate cannot be confirmed.

This case study shows how an otherwise innocuous synoptic situation can be enhanced by local effects. Perhaps southwesterly flow in advance of an approaching trough routinely produces extremely heavy weather in the Smith Sound area due to a channeling effect. In any event, these strong winds were not forecasted. Thus it behooves the Arctic forecaster to anticipate similar future events.

4.4.4 Conclusions

1. In regions of the Arctic, an approaching trough can produce extreme wind events if the flow is channeled from a larger to a smaller body of water when the wind is upchannel.
2. In spite of deep warm advection, significant vertical mixing can occur as long as weak, warm advection aloft overlies strong, low level, warm advection. This mechanism is just as effective for destabilization in cases where low level, warm advection is accompanied by strong, cold advection aloft.
3. The strongest winds associated with a cold frontal passage may be dangerously stronger ahead of the front rather than behind if local channeling effects are present.